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Effect of Cannabidiol (CBD) on Fertile Egg Production and Hatching Rate in Artificial Incubation

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Glossary

1. CBD (Cannabidiol): A non-psychoactive compound derived from Cannabis sativa with therapeutic properties (Islas-Andrade et al., 2023).

2. Hatching percentage: Number of chicks hatched relative to the total number of incubated eggs (Boleli et al., 2016).

3. Animal welfare: The optimal physical and emotional state of production animals (WOAH, 2025).

4. Endocannabinoid system: A network of receptors in vertebrate organisms that regulates various biological functions (Di Marzo & Piscitelli, 2015).

5. Environmental stimulus: External factors that may affect animal behavior and health (Koscinczuk, 2014).

6. Essential nutrients: Dietary components required for organism development and maintenance (Korver & Stewart-Brown, 2023).

Abstract

The objective of this research was to evaluate the effect of cannabidiol (CBD) on the hatching percentage of artificially incubated eggs from breeder hens subjected heat stress conditions. CBD was administered orally to the hens, and its effects on egg quality, hatching rate, and thermal stress mitigation were analyzed. Three experimental groups were compared: water, olive oil, and CBD. A significant increase in egg production and improvement in hatching percentage were observed in the CBD-treated group. The findings suggest that CBD enhances egg quality and hatching rates during artificial incubation, indicating potential benefits for mitigating thermal stress in poultry production.

Keywords: CBD, artificial incubation, heat stress, animal welfare, hatching percentage.

Problem Statement

The growing demand for high-quality chicks in backyard poultry production calls for innovative alternatives to improve reproductive efficiency. The use of CBD has been proposed as a strategy to enhance the welfare of hens under heat stress conditions, potentially leading to improved egg quality and higher hatching rates during artificial incubation. However, research on its specific impact during this critical phase of the production cycle remains scarce.

Target Users

The main beneficiaries of this research include the Secretaría de Agricultura y Desarrollo Rural (SADER), poultry producers seeking to improve reproductive efficiency, researchers in animal production and health, animal welfare regulators, and stakeholders promoting sustainable livestock systems..

Introduction

Poultry farming is one of the main agricultural activities worldwide, and artificial incubation plays a crucial role for optimizing chick production by allowing the control of critical environmental variables (Boleli et al., 2016). However, climate change has led to increased ambient temperatures, causing heat stress in birds, which negatively affects growth, feed intake, egg production, and the quality of hatching egg, in addition to increasing mortality rates (Goel, 2021). Although methods exist to mitigate this impact such as controlled environments, specialized diets, and nutritional supplements these resources are not always accessible to small-scale poultry producers (Pérez Soto et al., 2014).

Given the need for accessible and sustainable alternatives, cannabidiol (CBD), a phytocannabinoid derived from Cannabis sativa, has been studied for its potential to improve animal welfare under heat stress conditions. CBD interacts with the endocannabinoid system (ECS), a regulatory mechanism present in vertebrates including reptiles, birds, and mammals (Di Marzo & Piscitelli, 2015). The ECS consist of endocannabinoids, specific receptors (CB1 and CB2), and enzymes that regulate their degradation. CB1 receptors are found primarily in the brain and central nervous system, where they help regulate pain, anxiety, appetite, memory, and motor coordination. CB2 receptors are located mainly in peripheral organs associated with the immune system, playing a key role in modulating inflammation and immune response. Together, these receptors contribute to maintaining organismal homeostasis (Grotenhermen, 2005; Pertwee, 2015). CBD acts by inhibiting the fatty acid amide hydrolase (FAAH) enzyme, thereby increasing levels of endocannabinoids such as anandamide and enhancing their functions without psychoactive effects (Fallahi et al., 2022).

In poultry production, the inclusion of CBD in hens diet has been show to reduce stress and improve meat and eggs quality. Eggs from CBD-supplemented hens have exhibited higher levels of omega-3 and omega-6 fatty acids, along with improved nutritional value. An increase in egg size and modifications in the fatty acid composition of the meat have also been reported compared to hens fed conventional diets (Muedi et al., 2024). Beyond its benefits in poultry farming, cannabinoids have demonstrated therapeutic properties for various conditions, including analgesic, anticonvulsant, anti-inflammatory, anxiolytic, and antioxidant effects. Their use in animal production could not only enhance productivity and animal welfare but also reduce reliance on chemical products and pharmaceuticals, with positive implications for human health and the environment (Islas-Andrade et al., 2023).

The working hypothesis is that CBD administration to breeder hens will mitigate heat stress, which will be reflected in improved quality of hatching eggs, higher hatching percentages, and better chick quality under artificial incubation.

In this study, the effect of CBD on hatching egg quality, hatchability, and chick quality in artificial incubation was evaluated, aiming to generate information that could contribute to sustainable strategies in poultry production.

General Objective

To evaluate the effect of CBD on hatchability and the quality of chicks hatched from artificially incubated eggs.

Specific Objectives

To determine the influence of CBD on egg production and quality.

To compare the hatching rate of fertile eggs between hens treated and untreated with CBD.

To evaluate the welfare of hens under heat stress conditions when treated with CBD.

Materials and Methods

The study was conducted in the community of Felipe Carrillo Puerto, located in the municipality of Suchiapa, Chiapas, Mexico, located between 16°29’ to 16°42’ N latitude and 93°02’ to 93°15’ W longitude, at altitudes ranging from 400 and 1,400 meters above sea level. This region borders the municipalities of Tuxtla Gutiérrez to the north, Chiapa de Corzo to the east and south (along with Villaflores), and Villaflores, Ocozocoautla de Espinosa, and Tuxtla Gutiérrez to the west. The climate is warm sub-humid with summer rains and medium humidity, with temperatures ranging between 20°C and 36°C (CEIEG, 2025).

Experimental Design

A completely randomized design was used to evaluate the effect of CBD on egg production and quality, as well as on hatchability and chick development. Ninety 85-week-old Brown Nick breeder hens were randomly assigned to three experimental groups of 30 hens each, maintaining a ratio of three roosters per group.

All birds received identical management and were fed a commercial diet containing 16% crude protein at 118 g/bird/day, according to the Brazilian Tables for Poultry and Swine (2017) nutritional requirements for their physiological stage. Water was provided ad libitum. Ambient conditions ranged from a maximum of 38°C to a minimum of 18°C.

The experimental groups were as follows:

Group B1 – Olive oil control: hens received olive oil, without CBD.

Group B2 – Negative Control: hens received only water.

Group B3 – CBD in Olive Oil: hens received CBD dissolved in olive oil (300 µl [15 mg/hen]), according to manufacturer's instructions.

The use of these three groups allowed for the evaluation of CBD effects against two controls: one simulating the administration vehicle (olive oil) and another completely neutral (water), ensuring that any observed effects could be attributed to CBD rather than the carrier.

All treatments were administered orally via dropper (300 µL) at 12:00 p.m. daily, for 15 days before the selection of eggs and continuing through the 3-day collection period for viable eggs intended for incubation.

Egg Quality Selection

Viable eggs were selected through an external quality evaluation, considering:

Egg Weight: measured with a precision digital scale (Digital Pocket Scale, WeighMax, Model W-SM100, China, ±0.1 grams).

Shell Quality: integrity and cleanliness were verified, discarding eggs with cracks, fissures, or excessive dirt to prevent contamination and dehydration.

Shape and Texture: eggs with normal shape and texture were selected, avoiding deformities that could affect hatchability or chick quality, following the recommendations of Boleli et al. (2016).

Incubation Process

Selected eggs were incubated in an automatic incubator (Model 1000, Huacuja, Mexico) at 37.5°C and 60% relative humidity for the first 18 days, with automatic turning to ensure proper embryonic development. Eggs were then transferred to a hatcher (Model 1200, Huacuja, Mexico) for the remaining incubation period until day 21, maintaining optimal temperature and humidity conditions.

Candling and Fertility Assessment

Candling was performed between days 7 and 10 to differentiate between infertility and early embryonic mortality. Eggs showing no vascularization ("clear eggs") were identified by a change in yolk color and the presence or absence of embryonic development indicators such as fine blood vessels or the blastoderm (Ricaurte-Galindo, 2006). Candling was repeated on day 18 during transfer to the hatcher, and infertile eggs were removed.

Hatching and Chick Quality Evaluation

At the end of the incubation period, the following parameters were recorded:

Hatching Rate: calculated as (number of live chicks hatched ÷ total eggs incubated) × 100.

Chick Weight at Hatch: measured with a precision digital scale (Digital Pocket Scale, WeighMax, Model W-SM100, China, ±0.1 grams).

Chick Quality: assessed by physical appearance (dry, clean, and uniform down; closed and healed navel; strong and well-developed legs) and vitality (alert, active, with quick reflexes in response to light and sound stimuli). Optimal chick weight was considered 65–68% of egg weight (Ricaurte-Galindo, 2006).

Data Analysis

Data were analyzed using InfoStat v.2020.

Analysis of Variance (ANOVA): A completely randomized design was used for chick weight. For egg weight, a 2 × 3 factorial arrangement was applied, where one factor was pre- and post-treatment weight, and the second factor was the treatment (water, olive oil, CBD). Tukey's post hoc test was used to identify significant differences between groups. Pearson's Chi-Square Test: This test was used to evaluate the association between treatment groups and hatching success rate. It allowed us to determine whether there were significant differences in the proportion of incubated and hatched eggs among groups.

Contingency Tables: used to represent hatchability distribution per group. A significance level of p < 0.05 was used for all statistical tests.

These analyses enabled the evaluation of CBD's impact on poultry production, particularly on egg quality and chick development during artificial incubation.

Resultados

Egg Production and Quality

The analysis of variance for egg weight before and after treatment revealed a significant effect (p = 0.0026). The CBD-treated group B3 showed the highest average egg weight (54.87 g), compared with the water control group B2 (52.75 g) and the olive oil control group B1, (53.91 g). Notably, post-treatment egg weights in the CBD group reached an average of 55.64 g, the highest among all treatments, whereas the lowest average weight was recorded in the pre-treatment water control group (51.86 g) (Table 1).

Table 1. Factorial analysis of pre- and post-treatment egg weight

Factor	Mean ± SE
Pre-treatment	52.59 ± 0.36 a
Post-treatment	55.1 ± 0.35 b
Treatment	
B1 (Water)	52.75 ± 0.44 a
B2 (Olive oil)	53.91 ± 0.44 ab
B3 (CBD)	54.87 ± 0.42 b
Interactions	
Olive oil pre-treatment	51.8 ± 0.65 a
Water pre-treatment	51.86 ± 0.59 a
Water post-treatment	53.63 ± 0.65 ab
CBD pre-treatment	54.1 ± 0.65 ab
CBD post-treatment	55.64 ± 0.55 b
Olive oil post-treatment	56.03 ± 0.61 b

Note: Means with the same letter are not significantly different (*p* > 0.05).

Hatching Percentage

As shown in Table 2, the percentage of hatchable eggs was higher in the CBD group (B3, 64.28%) compared with the olive oil control (B2, 52.7%) and the water control (B1, 47.05%). However, Pearson's chi-squared test did not detect statistically significant differences among treatments ($\chi^2 = 2.40$, df = 2, p = 0.3013). This suggests a favorable trend for CBD, though a larger sample size would be required to confirm these results.

Table 2. Relative frequencies of egg hatchability with three different treatments

Treatment	Hatchable (%)	Non-hatchable (%)	Tota
Water	47.05	52.95	10
CBD	64.28	35.72	10
Olive oil	52.7	47.3	10

Note: Pearson Chi-square test *p* > 0.05.

Chick Weight and Quality

Chick weight at hatch differed significantly among treatments (p < 0.0001) (Table 3). The CBD-treated hens produced chicks with the highest mean hatch weight (57.0 g), followed by the water control (51.06 g) and olive oil control (46.74 g). Tukey's post hoc test confirmed statistically significant differences among all three groups. These results indicate that CBD supplementation improved embryonic development, leading to heavier and potentially more viable chicks at hatch.

Table 3. Weight of newly hatched chicks

Treatment	Mean (g)	SE
Olive oil	46.74 a	0.59a
Water	51.06 b	0.64b
CBD	57.0 c	0.49c

Note: Means with different superscripts differ significantly (*p* < 0.05).

Discussion

The results of this study support the use of cannabidiol (CBD) as a viable alternative to improve egg production and quality, as well as reproductive efficiency in breeder hens under heat stress conditions. Although thermal stress was not directly measured,

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CBD administration significantly increased both the weight of incubatable eggs and chick hatch weight, while also improving hatchability compared to the other treatments. These findings align with previous reports by Devitt-Lee (2023), who noted that CBD has anti-inflammatory and stress-modulating properties that could enhance metabolic response and physiological homeostasis in animals (Fallahi et al., 2022).

For example, Boleli et al. (2016) described how optimizing incubation conditions—such as temperature and humidity control—can improve embryo quality and chick hatchability. Likewise, studies on heat stress management in poultry have shown that environmental adjustments aimed at reducing heat-induced stress lead to improvements in reproductive performance and chick quality (Goel, 2021). In this context, CBD administration could play a similar role by enhancing the bird's physiological resilience to stress, acting as a modulator of chronic stress responses (Mortuza et al., 2023), and thereby improving embryonic development and hatching success.

In addition, studies in mammals have shown that cannabinoids can contribute to homeostasis by reducing oxidative stress and improving metabolic efficiency (Hampson et al., 1998). These mechanisms may also be present in birds, potentially explaining the increased chick weight observed in the CBD-treated group.

Olarte et al. (2024) further reported that stress reduction in poultry improves eggshell integrity and embryonic development, optimizing nutrient transfer to the embryo. This finding is consistent with our results, where CBD supplementation not only improved hatchability but also increased chick hatch weight—an important indicator of embryo viability and postnatal productivity in poultry farming.

Our analysis of variance revealed that the statistical model explained 76% of the variability in chick weight at hatch ($R^2 = 0.76$), indicating a strong model fit. A highly significant treatment effect was observed ($p < 0.0001$), confirming the positive influence of CBD. The Tukey test revealed statistically significant differences among all groups: the lowest mean weight in the olive oil group (46.74 g), intermediate in the water control (51.06 g), and finally group B3 (CBD), with the highest average chick weight (57.00 g). These differences suggest that CBD positively impacted embryonic development, potentially by improving nutrient transfer and embryonic metabolic efficiency.

Although the contingency table analysis did not show a statistically significant association between treatment type and hatchability, it did reveal a favorable trend in the CBD group. Taken together with findings from Fallahi et al. (2022) and Goel (2021), our results highlight the potential of CBD to enhance animal welfare and the sustainability of poultry production systems.

In summary, our findings suggest that CBD supplementation in breeder hens has beneficial effects on egg quality, hatchability, and chick weight at hatch. Nonetheless, further studies with larger sample sizes and experimental replication are recommended to validate the consistency of these results and elucidate the exact physiological mechanisms of CBD in avian species. Future research should also explore the long-term effects of CBD on poultry health and productivity, as well as assess the cost-effectiveness and regulatory considerations of its widespread use in the poultry industry.

Conclusions

The results of this study indicate that the administration of cannabidiol (CBD) to breeder hens under heat stress conditions significantly improves egg quality, hatchability, and chick weight at hatch. These findings suggest that CBD may serve as an effective strategy to mitigate the negative effects of thermal stress in poultry production, enhancing artificial incubation outcomes and promoting animal welfare.

CBD appears to act as a modulator of stress and physiological homeostasis, which positively influences reproductive performance. However, further research is needed to fully understand the mechanisms involved and to determine optimal, safe, and effective dosage levels for use in poultry systems.

Future research should focus on the long-term effects of CBD on poultry health and productivity, its impact on other performance indicators such as egg quality and feed conversion ratio, and the economic feasibility of large-scale implementation. Additionally, consumer perception and regulatory considerations regarding the use of CBD in animal production should be explored.

In summary, CBD supplementation represents a promising and innovative approach for improving reproductive performance and sustainability in the poultry industry.

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Socioeconomic Impact

The integration of cannabidiol (CBD) into poultry production systems holds promising socioeconomic benefits that could positively influence both the industry and society at large.

Improved productivity and profitability: By enhancing key production parameters—such as hatchability, chick quality, and egg weight—CBD supplementation may increase the overall efficiency and profitability of poultry farms. This is especially relevant for small and medium-scale producers facing productivity losses due to heat stress and environmental challenges (Konieczka et al., 2020).

Reduction in antibiotic use: The potential of CBD to act as a natural immunomodulator and anti-inflammatory agent may reduce the need for conventional antibiotics, contributing to safer food products and addressing global concerns over antimicrobial resistance (Blaskovich et al., 2021).

Animal welfare and sustainability: CBD's antioxidant and anti-inflammatory properties can improve birds' general health, reduce stress, and promote animal welfare (Hampson et al., 1998). These improvements align with modern consumer trends favoring ethical and environmentally sustainable food production systems. As noted by Facundo (2024), the market appeal of natural additives such as CBD may also enhance the economic value of poultry-derived products.

Nevertheless, the widespread adoption of CBD in animal agriculture faces regulatory, scientific, and economic challenges. Issues such as product standardization, legal frameworks, long-term safety, and cost-benefit analysis must be thoroughly addressed. Scientific validation of its efficacy, consumer education, and clear regulatory guidance will be essential to ensure its responsible use.

In conclusion, the application of CBD in poultry farming offers a novel and potentially transformative approach to increasing productivity, promoting animal health, and supporting sustainable agricultural practices. With appropriate oversight and research, it could contribute to more resilient and ethically sound food systems.

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